[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket No. EERE-2016-BT-TP-0018]

RIN 1904-AD68

Energy Conservation Program: Test Procedure for Uninterruptible Power Supplies

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Notice of proposed rulemaking.

SUMMARY: The U.S. Department of Energy (DOE) is proposing to revise its battery charger test procedure established under the Energy Policy and Conservation Act of 1975, as amended. These proposed revisions, if adopted, will add a discrete test procedure for uninterruptible power supplies (UPSs) to the current battery charger test procedure.

DATES: Meeting: DOE will hold a public meeting on Thursday, June 9, 2016, from 9:30 a.m. to 12:30 p.m., in Washington, DC. The meeting will also be broadcast as a webinar. See section V, "Public Participation," for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

Comments: DOE will accept comments, data, and information regarding this notice of proposed rulemaking (NOPR) before and after the public meeting, but no later than [**INSERT DATE 60 DAYS**

AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]. See section V, "Public Participation," for details.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 8E-089, 1000 Independence Avenue, SW., Washington, DC 20585.

Any comments submitted must identify the NOPR for Test Procedure for Battery Chargers, and provide docket number EE-2016–BT–TP–0018 and/or regulatory information number (RIN) number 1904-AD68. Comments may be submitted using any of the following methods:

1. Federal eRulemaking Portal: www.regulations.gov. Follow the instructions for submitting comments.
2. E-mail: UPS2016TP0018@ee.doe.gov. Include the docket number and/or RIN in the subject line of the message.
3. Mail: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, Mailstop EE-2J, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.
4. Hand Delivery/Courier: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC, 20024. Telephone: (202) 586-2945. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

For detailed instructions on submitting comments and additional information on the rulemaking process, see section V of this document (Public Participation).

Docket: The docket, which includes Federal Register notices, public meeting attendee lists and transcripts, comments, and other supporting documents/materials, is available for review at http://www.regulations.gov/#!docketDetail;D=EERE-2016-BT-TP-0018. All documents in the docket are listed in the www.regulations.gov index. However, some documents listed in the index, such as those containing information that is exempt from public disclosure, may not be publicly available. The www.regulations.gov web page contains simple instructions on how to access all documents, including public comments, in the docket. See section V for information on how to submit comments through www.regulations.gov.

FOR FURTHER INFORMATION CONTACT:

Jeremy Dommu, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE-5B, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 586-9870. E-mail: battery_chargers_and_external_power_supplies@ee.doe.gov

In the Office of the General Counsel, contact Mr. Pete Cochran, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 586–9496. E-mail: peter.cochran@hq.doe.gov.

For further information on how to submit a comment, review other public comments and the docket, or participate in the public meeting, contact Ms. Brenda Edwards at (202) 586-2945 or by email: Brenda.Edwards@ee.doe.gov.

SUPPLEMENTARY INFORMATION:

This proposed rule would incorporate by reference into 10 CFR part 430 the testing methods contained in the following commercial standard:

IEC 62040-3, "Uninterruptible power systems (UPS) – Method of specifying the performance and test requirements," Edition 2.0, Section 6 "UPS tests," and Annex J "UPS efficiency – Methods of measurement."

Copies of the IEC 62040-3 Ed. 2.0 standard are available from the American National Standards Institute, 25 W. 43rd Street, 4th Floor, New York, NY 10036 or at http://webstore.ansi.org/.

See section IV.M for further discussion of this standard.

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I. Authority and Background

Title III of the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6291, et seq.; "EPCA" or, "the Act") sets forth a variety of provisions designed to improve energy efficiency.[1] Part B[2] of title

[1] All references to EPCA refer to the statute as amended through the Energy Efficiency Improvement Act, Public Law 114-11 (April 30, 2015).
[2] For editorial reasons, Part B was redesignated as Part A upon incorporation into the U.S. Code (42 U.S.C. 6291–6309, as codified).

III, established the "Energy Conservation Program for Consumer Products Other Than Automobiles." Battery chargers are among the consumer products affected by these provisions. (42 U.S.C. 6295(u))

Under EPCA, the energy conservation program consists essentially of four parts: (1) testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and enforcement procedures. The testing requirements consist of test procedures that manufacturers of covered products must use as the basis for (1) certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA, and (2) making representations about the efficiency of those products. Similarly, DOE must use these test procedures to determine whether the products comply with any relevant standards promulgated under EPCA.

General Test Procedure Rulemaking Process

Under 42 U.S.C. 6293, EPCA sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered products. EPCA provides in relevant part that any test procedures prescribed or amended under this section shall be reasonably designed to produce test results which measure energy efficiency, energy use or estimated annual operating cost of a covered product during a representative average use cycle or period of use and shall not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(3))

In addition, if DOE determines that a test procedure amendment is warranted, it must publish proposed test procedures and offer the public an opportunity to present oral and written comments on them. (42 U.S.C. 6293(b)(2)) Finally, in any rulemaking to amend a test procedure, DOE must

determine to what extent, if any, the proposed test procedure would alter the measured energy efficiency of any covered product as determined under the existing test procedure. (42 U.S.C. 6293(e)(1))

Background

The "Uniform Test Method for Measuring the Energy Consumption of Battery Chargers" in appendix Y to subpart B of 10 CFR part 430 specifies the testing requirements for battery chargers. DOE last amended this test method with the publication of a test procedure final rule on June 1, 2011, which codified a new active-mode test procedure and amended the existing standby and off-mode test procedures. 76 FR 31750. As federal standards for battery chargers have yet to be finalized, DOE has not required manufacturers to submit energy efficiency data for their products tested under the battery charger test procedure.

DOE published a notice of proposed rulemaking (NOPR) on March 27, 2012, regarding energy conservation standards for battery chargers and external power supplies (March 2012 NOPR) where it proposed standards for battery chargers, including uninterruptible power supplies (UPSs). 77 FR 18478

Following the publication of the 2011 battery charger test procedure final rule and the March 2012 NOPR, DOE explored whether to regulate UPSs as "computer systems." See, e.g., 79 FR 11345 (Feb. 28, 2014) (proposed coverage determination); 79 FR 41656 (July 17, 2014) (computer systems framework document). DOE received a number of comments in response to those documents (and the related public meetings) regarding testing of UPSs, which are discussed in this NOPR. At the same time, DOE received questions and requests for clarification regarding the testing, rating, and classification of battery chargers.

As part of the continuing effort to establish federal efficiency standards for battery chargers and to develop a clear and widely applicable test procedure, DOE published a notice of data availability (May 2014 NODA) on May 15, 2014. 79 FR 27774. This NODA sought comments from stakeholders concerning the repeatability of the test procedure when testing battery chargers with several consumer configurations and on the future market penetration of new battery charging technologies that may require revisions to the battery charger test procedure. DOE also sought comments on the reporting requirements for manufacturers attempting to comply with the California Energy Commission's (CEC's) efficiency standards for battery chargers in order to understand certain data discrepancies in the CEC database. These issues were discussed during DOE's NODA public meeting on June 3, 2014.

Based upon discussions from the May 2014 NODA public meeting and written comments submitted by various stakeholders, DOE published a NOPR (August 2015 NOPR) to revise the current battery charger test procedure on August 6, 2015. 80 FR 46855. DOE received a number of stakeholder comments on the August 2015 NOPR and the computer systems framework document regarding regulation of battery chargers including UPSs. After considering these comments, DOE reconsidered its position and found that since a UPS meets the definition of a battery charger, it is more appropriate to regulate UPSs as part of the battery charger rulemaking. Therefore, in today's notice DOE proposes to amend the battery charger test procedure to include specific test provisions for UPSs.

II. Synopsis of the Notice of Proposed Rulemaking

This proposal seeks to add provisions for testing UPSs to the battery charger test procedure. Specifically, DOE is proposing to incorporate by reference specific sections of IEC 62040-3 Ed 2.0 with additional instructions, into the current battery charger test procedure published at appendix Y to subpart B of 10 CFR part 430. Additionally, this proposal seeks to add formal definitions for uninterruptible power supply, voltage and frequency dependent UPSs, voltage independent UPSs, voltage and frequency independent UPSs, energy storage systems, normal mode and reference test load to appendix Y to subpart B of 10 CFR part 430 and revise the compliance certification requirements for battery chargers published at 10 CFR 429.39.

III. Discussion

In response to the August 2015 NOPR, DOE received written comments from 18 interested parties, including manufacturers, trade associations, standards development organizations and energy efficiency advocacy groups. Table III-1 below lists only the entities that commented on the proposed exclusion of UPSs, as battery chargers. These comments are discussed in further detail below. The full set of comments on the battery charger test procedure NOPR can be found at: http://www.regulations.gov/#!docketBrowser;rpp=25;po=0;dct=PS;D=EERE-2014-BT-TP-0044

Table III-1 Interested Parties That Provided Written Comments on Proposed Exclusion of UPSs as Battery Chargers in the August 2015 NOPR

Commenter	Acronym	Organization Type/Affiliation	Comment No. (Docket Reference)
California Investor Owned Utilities	CA IOUs	Utility Association	21
Natural Resources Defense Council, Appliance Standards Awareness Project, and Northwest Energy Efficiency Alliance	NRDC, ASAP, and NEEA	Energy Efficiency Advocacy Groups	20

Schneider Electric	Schneider Electric	Manufacturer	12

Similarly, in response to the computer systems framework document, DOE received written comments from 9 interested parties, including manufacturers, trade associations, standards development organizations, and energy efficiency advocacy groups. Table III-2 below lists only the entities that commented on the inclusion of UPSs in the computer systems rulemaking. These comments are also discussed in detail below. The full set of comments on the computer systems framework document can be found at: http://www.regulations.gov/#!docketBrowser;rpp=25;po=0;dct=PS;D=EERE-2014-BT-STD-0025

Table III-2 Interested Parties That Provided Written Comments on the Inclusion of UPSs in the Computer Systems Framework Document

Commenter	Acronym	Organization Type/Affiliation	Comment No. (Docket Reference)
Information Technology Industry Council	ITI	Trade Association	10
National Electrical Manufacturers Association	NEMA	Trade Association	15
Schneider Electric	Schneider Electric	Manufacturer	08

A. Covered Products and Scope

DOE has proposed several different methods of handling UPSs throughout the course of the battery chargers and computer systems rulemakings. Originally, DOE had proposed energy conservation standards for UPSs as part of the 2012 battery chargers NOPR. DOE proposed that UPSs be part of product class 10a and 10b and be regulated using the same energy consumption metric (annual unit energy consumption or "UEC") and test procedure as all other battery chargers, using a usage

profile assumption for those product classes that is typical of UPSs. 77 FR 18478. However, in 2014, DOE proposed that UPSs be included as part of the proposed coverage determination for computer systems. As outlined in the computer systems framework document, DOE sought stakeholder feedback of its consideration of referencing IEC 62040-3 Edition 2.0, "Uninterruptible power systems (UPS) – Method of specifying the performance and test requirements", March 2011 (IEC 62040-3 Ed. 2.0), as the test procedure for UPSs with the inclusion of additional instructions from ENERGY STAR UPS Version 1.0, "ENERGY STAR Program Requirements for Uninterruptible Power Supplies," Rev. July 2012 (ENERGY STAR UPS V. 1.0). This test procedure would measure the average conversion efficiency of a UPS with test loads connected to the UPS.

DOE received comments on the battery charger test procedure NOPR from Schneider Electric and the CA IOUs opposing the exclusion of UPSs from the scope of the battery charger test procedure. These stakeholders highlighted the usage of the current battery charger test procedure by CEC to regulate UPSs under the state's own battery charger energy conservation program. (Docket No. EERE-2014-BT-TP-0044, Schneider Electric, No, 12 at p. 1, Docket No. EERE-2014-BT-TP-0044, CA IOUs, No. 21 at p. 3) Their comments emphasize that UPSs are a type of backup battery charger and should remain in the scope of the battery charger test procedure. Similarly, NRDC, ASAP, and NEEA submitted comments recommending that battery backup systems be included in the scope of the battery charger test procedure. Further, NRDC, ASAP, and NEEA recommended that DOE exclude battery backup systems as a covered product in order to allow the CEC to continue to enforce its standards for these products until the computer systems standards become effective. (Docket No. EERE-2014-BT-TP-0044, NRDC, ASAP, and NEEA, No. 20, p. 2)

After considering all related stakeholder comments, DOE believes that it is most appropriate to include UPSs within the scope of the battery charger test procedure. Although UPSs may provide various types of power conditioning and monitoring functionality depending on their architecture and input dependency, they primarily maintain the fully-charged state of lead acid batteries with relatively high self-discharge rates so that in the event of a power outage, they are able to provide backup power instantly to the connected load. Maintaining the lead acid battery therefore directly affects a UPS's overall energy efficiency. In 10 CFR 430.2, a battery charger is defined as a device that charges batteries for consumer products. Because UPSs that are in scope of this rulemaking have the primary task of maintaining a charged lead acid battery, DOE concludes that UPSs meet the definition of a battery charger and, as such, should be considered within the scope of the battery charger test procedure.

UPSs are defined in IEC 62040-3 Ed. 2.0 as a combination of convertors, switches and energy storage devices (such as batteries), constituting a power system for maintaining continuity of load power in case of input power failure. Today, DOE proposes to adopt this definition for UPSs; that is, only battery chargers that meet the above-stated definition of a UPS are subject to the testing requirements proposed in this NOPR. While UPSs with a variety of architectures, input dependency and input/output characteristics may meet IEC's definition, DOE is further proposing to limit the applicability of this test procedure to only those that have an AC output to help limit the scope of the UPS test procedure. DOE emphasizes that this proposal to include specific test provisions for UPSs in the battery charger test procedure only applies to products that meet the above stated definition of a UPS and have an AC output.

DOE requests comment on the proposal to include specific test provisions for UPSs, as defined above, in the battery charger test procedure.

B. Existing Test Procedures and Standards Incorporated by Reference

DOE is proposing to add specific testing provisions for UPSs in the battery charger test procedure, as the Department believes that the specifications in the current battery charger test procedure are not appropriate for UPSs. Most battery chargers have four modes of operation: (1) active mode (charging batteries that are at various stages of depletion); (2) maintenance mode (maintaining fully charged batteries); (3) standby mode (plugged in with no battery connected to charge and all manual on-off switches turned on); and (4) off mode (plugged in with no battery connected to charge and all manual on-off switches turned off). The current battery charger test procedure measures energy consumption in these modes because most battery chargers generally spend a significant amount of time in all four modes of operation. Most battery chargers are used to charge the batteries of products that are designed to be regularly operated using battery power. This makes the current test procedure output metrics appropriate for representing the energy consumption of most kinds of battery chargers during a representative average use cycle.

In contrast, the current test procedure, which measures energy consumption of a battery charger as it charges a fully discharged battery, is inappropriate for a UPS since a UPS rarely has a fully discharged battery. The UPS's battery is only infrequently depleted during a power outage when a connected load discharges the energy stored within the UPS's battery in order to continue normal operation of the powered product. Likewise, it is only after power has been restored following an outage that the UPS charges depleted batteries. The vast majority of the time a UPS provides a small

amount of charge necessary to maintain fully charged batteries and also delivers power to a connected load. Therefore, in order to accurately capture the energy consumption and energy efficiency of the normal operation of a UPS, the test procedure should measure the energy consumption of maintaining a fully charged battery and the conversion losses associated with delivering load power.

The following subsections discuss each mode of operation that is currently included within the DOE battery charger test procedure, and the rationale for why each mode is not applicable to UPSs.

1. Active mode: Section 2.1 of appendix Y to subpart B of 10 CFR part 430 defines active mode or charge mode as a state in which the battery charger system is connected to the main electricity supply, and the battery charger is delivering current, equalizing cells, and performing other one-time or limited-time functions in order to bring the battery to a fully charged state. In active mode, the battery charger is charging a battery that is partially or fully discharged. However, unlike other battery chargers, UPSs seldom have a fully-discharged battery. UPSs primarily maintain the fully-charged state of their internal batteries so that in the event of a power outage, the internal batteries are able to instantly provide backup power to a connected load. However, power outages are infrequent in the United States and therefore a UPS rarely switches to backup power and consumes its stored energy. Because the battery is maintained in a fully charged state during the majority of a UPS's service life, UPSs are almost never required to enter active mode to replenish a depleted battery. Consequently, it would not be appropriate to measure the active mode energy consumption of a UPS by the current battery charger test procedure because the resulting measured energy would not be representative for a UPS in typical use as required by 42

U.S.C. 6293(b)(3). Two other outputs of the current test procedure, battery capacity and charge time, are related to measuring the energy consumption in active mode. Because the active mode is generally not common for a UPS, measuring battery capacity and charge time would typically not be representative.

2. Maintenance mode: Once the batteries have been fully charged, a battery charger typically enters a maintenance mode intended to maintain the fully charged state of batteries with a finite self-discharge rate, while protecting it from overcharging. Although UPSs spend the majority of their service life in this mode, UPSs also continuously provide power to a connected load. This aspect is missing from the current battery charger test procedure, which does not require a load to be connected to the battery charger – only to a battery. UPSs are almost always connected to a load, such as a computer, because the primary purpose of a UPS is to provide power in the event of an unexpected power outage. Leaving the UPS unconnected to a load would not be representative of typical usage, and the resulting measured energy consumption would not be representative, as required by 42 U.S.C. 6293(b)(3).

3. Standby and off modes: The current battery charger test procedure requires that, in addition to active and maintenance mode, a battery charger's energy consumption be measured in two other modes of operation; standby and off mode. In standby mode, the battery charger remains connected to the main electricity supply with the battery itself disconnected and all manual on-off switches (if applicable) turned on. In off mode, the battery charger remains connected to the main electricity supply with the battery itself disconnected and all manual

on-off switches (if applicable) turned off. UPSs never experience these modes of operation in typical use since they are always connected to mains power and have batteries attached in order to service their loads in the event of a power outage. Therefore, testing UPSs in standby and off modes would not be representative of typical usage, and the resulting measured energy consumption would not be representative, as required by 42 U.S.C. 6293(b)(3).

As each of the modes of operation discussed above is not directly applicable to UPSs, DOE proposes to amend the current battery charger test procedure to add auxiliary instructions for testing a UPS that will better capture the device's real world energy performance. More specifically, DOE proposes to define "normal mode" as a mode of operation where the UPS maintains a battery while simultaneously powering a connected load.

In order to measure energy consumption during normal mode, DOE proposes to incorporate by reference Section 6 and Annex J of IEC 62040-3 Ed. 2.0 in the battery charger test procedure. This test method requires that power consumption of a UPS be measured in normal mode with reference test loads equal to 25%, 50%, 75%, and 100% of the unit's rated power. Each of these individual efficiency data points is then weighted by a coefficient that is specific for each UPS architecture and combined to determine the overall average efficiency of the unit. DOE is aware that the IEC standard is under revision and will consider amending this test procedure to further harmonize with any finalized revision of this industry test procedure. Furthermore, DOE proposes to include additional instructions, some of which are provided in the ENERGY STAR UPS V. 1.0 specification. Discussion of these additional instructions is found in sections III.C and III.D of this proposed rule.

DOE requests stakeholder comments on the type of changes that are being considered for the revised IEC 62040-3 standard and how it may impact the test procedure proposed today.

Because DOE is proposing to adopt testing requirements for UPSs from IEC 62040-2 Ed. 2.0 with additional instructions where appropriate, the following sections discuss these proposed requirements including definitions, test conditions, battery and product configuration, average power and efficiency calculations, output metric, effective date and compliance requirements, sampling plan and certification reports.

C. Definitions

DOE proposes to include the following definitions, in alphabetical order, in section 2 of appendix Y to subpart B of 10 CFR part 430. DOE requests comment on all proposed definitions, particularly those that are not defined in existing industry standards.

1. Energy Storage System

DOE proposes the following definition for an Energy Storage System of a UPS:

"*Energy storage system* is a system consisting of single or multiple devices designed to provide power to the UPS inverter circuitry."

2. Normal Mode

Normal mode for UPSs is similar to the maintenance mode of other battery chargers as defined in appendix Y to subpart B of 10 CFR part 430 in that the UPS maintains the fully charged state of batteries with a finite self-discharge rate, while protecting it from overcharging. However, in addition to maintaining a battery, a UPS in normal mode also continuously provides power to a load. In order to highlight this distinction, DOE proposes the following definition for the normal mode of operation for a UPS.

"*Normal mode* is a mode of operation for a UPS in which:

(i) The UPS provides required output power to the connected load without switching to battery power,

(ii) the energy storage system is being maintained at full charge, and (iii) the load connected to the UPS is within the UPS's specified power rating."

3. Reference Test Load

To describe the load that is used for testing UPSs, DOE proposes the following definition for reference test load.

"*Reference test load* is a load or condition with a power factor of greater than 0.99 in which the AC output socket of the UPS delivers the active power (W) for which the UPS is rated."

While IEC 62040-3 Ed. 2.0 also provides a definition for reference test load, it does not explicitly address whether such a test load is linear or non-linear in nature. Similarly, section 4.2 of ENERGY STAR UPS V. 1.0 calls for the reference test load to be resistive without clearly defining the

term ‘resistive’. DOE’s proposed definition properly characterizes the test load to be used for UPS testing and removes ambiguity by requiring the test load to be linear and resistive through the power factor requirement.

4. Uninterruptible Power Supplies

DOE proposes the following definition for a UPS:

“*Uninterruptible power supply* or *UPS* means a battery charger consisting of a combination of convertors, switches and energy storage devices, constituting a power system for maintaining continuity of load power in case of input power failure.”

DOE is also proposing to include definitions for voltage independent, voltage and frequency dependent, and voltage and frequency independent UPS architectures based on the definitions from section 1.0 of ENERGY STAR UPS V. 1.0 to differentiate between different UPS load ratings. The proposed definitions are as follows:

“*Voltage and frequency dependent UPS* or *VFD UPS* means a UPS that produces an alternating current (AC) output where the output voltage and frequency are dependent on the input voltage and frequency. This UPS architecture does not provide corrective functions like those in voltage independent and voltage and frequency independent systems.”

A typical VFD UPS connects the protected load directly to the main electricity supply without performing any voltage or frequency conditioning. In the event the input voltage or frequency fails or

simply falls outside a manufacturer-specified range, the VFD UPS shifts the source of the output power from the main electricity supply to the battery power by detecting the fault condition and turning on the internal DC to AC inverter circuitry. Because the detection of a fault condition and the subsequent turning on of the DC to AC inverter circuitry requires a finite amount of time, the switchover process is not instantaneous and generally requires tens of milliseconds. This UPS architecture may therefore not be suitable for protecting loads that are sensitive to brief dips and surges in the input power supply.

"*Voltage independent UPS* or *VI UPS* means a UPS that produces an AC output within a specific tolerance band that is independent of under-voltage or over-voltage variations in the input voltage. The output frequency of a VI UPS is dependent on the input frequency, similar to a voltage and frequency dependent system."

A VI UPS functions similarly to a VFD UPS in that it also powers the protected load using the main electricity supply. However, unlike a VFD UPS, a VI UPS is able to perform minor conditioning of the input voltage when it is marginally out of tolerance without switching to battery power. A VI UPS typically achieves this by using a Buck-boost transformer, a component that can detect dips and surges in the input voltage and adjust its winding ratio such that the output voltage remains constant. However, if the perturbation in the input voltage is greater than a predetermined range set by the manufacturer, the VI UPS will switch to the battery power similar to a VFD UPS. A VI UPS is unable to protect the load against fluctuations in the input frequency without switching to battery power.

"*Voltage and frequency independent UPS* or *VFI UPS* means a UPS where the device remains in normal mode producing an AC output voltage and frequency that is independent of input voltage and

frequency variations and protects the load against adverse effects from such variations without depleting the stored energy source. The input voltage and frequency variations through which the UPS must remain in normal mode are as follows:

i. ± 10 % of the rated input voltage or the tolerance range specified by the manufacturer, whichever is greater; and

ii. ± 2 % of the rated input frequency or the tolerance range specified by the manufacturer, whichever is greater."

A VFI UPS consists of an AC to DC converter that charges the UPS battery and a DC to AC inverter that converts the DC battery voltage back to AC in order to power the connected load. However, unlike a VFD or a VI UPS where the DC to AC inverter is turned on only when a fault condition is detected, the inverter in a VFI UPS is always in operation ensuring that the connected load is always powered through the battery power, which is continuously charged using main electricity supply. The use of a VFI device is particularly important when the protected load is sensitive to the slightest change in input voltage and frequency.

To help manufacturers determine whether a UPS is properly considered to be VFD, VI, or VFI, DOE is including tests to verify the input dependency of the UPS as follows: VI input dependency may be verified by performing the steady state input voltage tolerance test in section 6.4.1.1 of IEC 62040-3 Ed. 2.0 and observing that the output voltage remains within the specified limit during the test. VFD input dependency may be verified by performing the AC input failure test in section 6.2.2.7 of IEC 62040-3 Ed. 2.0 and observing that, at a minimum, the UPS switches from normal mode of operation to battery power while the input is interrupted. VFI input dependency may be verified by performing the

steady state input voltage tolerance test and the input frequency tolerance test specified in sections 6.4.1.1 and 6.4.1.2 of IEC 62040-3 Ed. 2.0 and observing that, at a minimum, the output voltage and frequency remain within the specified output tolerance band during the test. These tests may be performed to determine the input dependency supported by the test unit.

D. Test Conditions

Although a majority of the test conditions are adopted from the IEC 62040-3 Ed 2.0 standard, DOE proposes certain supplementary instructions for the test conditions in appendix Y to subpart B of 10 CFR part 430 in order to eliminate the possibility of ambiguity. DOE requests comment on the proposed test conditions.

1. Accuracy and Precision of Measuring Equipment

In this NOPR, DOE proposes that the power meter and other equipment used during the test procedure must provide true root mean square (r. m. s.) measurements of the active input and output power, with an uncertainty at full rated load of less than or equal to 0.5 percent at the 95 percent confidence level notwithstanding that voltage and current waveforms can include a harmonic component. Further, DOE proposes that the power meter and other equipment must measure input and output values simultaneously.

2. Environmental Conditions

IEC 62040-3 Ed 2.0 requires that the ambient temperature must be in the range of 20 °C to 30 °C. In order to ensure repeatability, DOE proposes to increase the precision required for ambient temperature measurements, while keeping the same range. As a result, the ambient temperature must be

20.0 °C to 30.0 °C (i.e., increasing the required precision by one decimal place) and the measurement must include all uncertainties and inaccuracies introduced by the temperature measuring equipment. Extending the precision of IEC's ambient temperature range requirement by one decimal place allows DOE to minimize rounding errors and avoid scenarios where a temperature of 19.6 °C would be rounded to 20 °C during testing and potentially provide higher efficiency usage values than those obtained at or above 20.0 °C. The proposal also requires that the tests be carried out in a room with an air speed immediately surrounding the unit under test (UUT) of less than or equal to 0.5 m/s. There must be no intentional cooling of the UUT such as by use of separately powered fans, air conditioners, or heat sinks. The UUT must be tested on a thermally non-conductive surface.

3. Input Voltage and Frequency

DOE proposes that the AC input voltage to the UUT be within 3 percent of the highest rated voltage and the frequency be within 1 percent of the highest rated frequency of the device.

E. Battery Configuration

Section J.2.2 of the IEC 62040-3 Ed. 2.0 standard requires that the UPS operate in normal mode during testing and that the transfer of energy to and from the energy storage system be prevented during the test. Further, IEC recommends disconnecting the energy storage system to prevent such transfer of energy. While this approach is appropriate for measuring the losses within the inverter components, disconnecting the energy storage system prevents the capturing of losses in the battery charger components of the UPS. UPSs covered under today's proposed scope most commonly use lead acid batteries as their energy storage systems, and these batteries have a relatively high self-discharge rate. Over time, these UPSs expend a considerable amount of cumulative energy countering the self-

discharge of fully charged lead acid batteries in real life use under normal mode operation. Disconnecting the battery during testing as recommended by IEC will fail to account for this additional energy spent by the battery charging components. Because DOE intends to capture a complete picture of the energy performance of UPSs as part of today's rulemaking, DOE proposes that the energy storage systems must remain connected throughout the test.

Batteries in UPSs must remain fully charged, standing by to provide backup power in the event of a power failure. Battery charging requirements must therefore be standardized such that the batteries are fully charged during testing and representative of the state of a UPS in real life use. Therefore, DOE proposes to standardize battery charging requirements for UPSs by including the following instructions in section 4.2.1 of appendix Y to subpart B of 10 CFR part 430. These requirements, which ensure that the battery is fully charged prior to testing, specify charging the battery for an additional 5 hours after the UPS has indicated that it is fully charged, or, if the product does not have a battery indicator but the user manual specifies a time, charging the battery for 5 hours longer than the manufacturer's estimate. Finally, the proposal requires charging the battery for 24 hours if the UPS does not have an indicator or an estimated charging time.

F. Product Configuration

For configuring UPSs for testing, DOE proposes to incorporate by reference Appendix J.2 of IEC 62040-3 Ed 2.0 in section 4.2.1 of the proposed appendix Y to subpart B of the 10 CFR part 430. In addition to the IEC test method, DOE proposes to include additional requirements for UPS operating mode conditions and energy storage system derived from ENERGY STAR UPS V. 1.0. DOE is not

considering including requirements for back-feeding, which are specified in ENERGY STAR UPS V. 1.0 because back-feeding will not apply to the UPSs that are in the proposed scope of this rulemaking.

G. Average Power and Efficiency Calculation

1. Average Power

DOE proposes two different methods for calculating average power so that manufacturers have the option of using a method better suited to the testing equipment already available at their disposal without have to purchasing new equipment. DOE believes this will reduce testing burden. DOE proposes to specify these calculation methods in section 4.3.1 of the proposed appendix Y to subpart B of 10 CFR part 430. The first proposed method of calculating average power is to divide accumulated energy (E_i) by the specified period for each test (T_i) and recording the accumulated energy (E_i) in kWh. For this method, the average power is calculated using the following equation:

$$P_{avg} = \frac{E_i}{T_i}$$

Additionally, DOE proposes a second method to calculate average power by sampling the power at a rate of at least 1 sample per second and computing the arithmetic mean of all samples over the time period specified for each test (T_i). For this method, the average power (P_{avg}) is calculated using the following equation:

$$P_{avg} = \frac{1}{n}\sum_{i=1}^{n} P_i$$

Where P_{avg} represents average power, P_i represents measured power during a single measurement (*i*), and *n* represents total number of measurements.

DOE requests comment on the proposed two different methods of calculating average power. DOE requests comment on the comparability of the results from the two methods.

2. Efficiency

DOE proposes to calculate the efficiency of UPSs at each loading point as specified in section J.3 of IEC 62040-3 Ed 2.0. DOE also proposes additional requirements from ENERGY STAR UPS V. 1.0 for the purpose of ensuring repeatable and reproducible tests. ENERGY STAR UPS V. 1.0 specifies requirements for ensuring the unit is at steady state and calculating the efficiency measurements. DOE also proposes to require that the input dependency of the UPS be determined as described in section III.C.4 of this NOPR. The proposed requirements are included in section 4.3 of the proposed appendix Y to subpart B of 10 CFR part 430.

H. Output Metric

To capture the energy efficiency of a UPS, DOE proposes that the device be tested in normal mode. DOE further proposes to use an average load adjusted efficiency metric, rounded to one tenth of a percentage point, as the final output of this UPS test procedure. DOE's proposed output metric for UPSs matches the output metric utilized by ENERGY STAR UPS V. 1.0. DOE is also proposing to adopt the load weightings specified in ENERGY STAR UPS V. 1.0 for calculating load adjusted average efficiency of UPSs. These load weightings vary based on the ratio of the reference test load to the full rated load of the device, the UPS architecture and the output power rating of a UPS.

These weightings are widely used by manufacturers to certify their UPSs to ENERGY STAR specifications and indicate the typical amount of time a UPS spends at each loading point. Therefore, DOE believes the use of load weightings allow the proposed final metric to capture the real world energy performance of UPSs accurately and representatively. The requirements for calculating the final metric, shown in Table III-3, are proposed to be incorporated in section 4.3.5 of appendix Y to subpart B of 10 CFR part 430. The proposed equation to calculate the average load adjusted efficiency of UPSs is as follows:

$$\text{Eff}_{\text{avg}} = (t_{25\%} \times \text{Eff}|_{25\%}) + (t_{50\%} \times \text{Eff}|_{50\%}) + (t_{75\%} \times \text{Eff}|_{75\%}) + (t_{100\%} \times \text{Eff}|_{100\%})$$

Where:

Eff_{avg} = average loading-adjusted efficiency

$t_{n\%}$ = proportion of time spent at the particular *n%* of the reference test load

$\text{Eff}_{n\%}$ = efficiency at the particular *n%* of the reference test load

Table III-3: UPS Load Weightings for Calculating Average Efficiency

		Portion of time spent at reference load			
Rated output power (W)	**Input Dependency Characteristic**	**25%**	**50%**	**75%**	**100%**
P ≤ 1500 W	VFD	0.2	0.2	0.3	0.3
	VI or VFI	0	0.3	0.4	0.3
P > 1500 W	VFD, VI, or VFI	0	0.3	0.4	0.3

EISA 2007 amended EPCA to require DOE to implement a standby and off mode energy consumption measurement, if technically feasible, in new or existing test procedures that do not have this measurement. (42 U.S.C. 6295(gg)(2)(A)) EISA 2007 also requires any final rule establishing energy conservation standards for a covered product, adopted after July 1, 2010, to incorporate standby

mode and off mode energy use into a single amended or new standard, if feasible. (42 U.S.C. 6295(gg)(3)(A))

EPCA defines the three modes that consumer products can be in as: (1) active mode, (2) standby mode, and (3) off mode. (42 U.S.C. 6295(gg)(1)) DOE incorporated EPCA's definitions for active, standby, and off modes into 10 CFR 430.2. Each of these definitions requires that the product be "connected to a main power source." DOE is proposing a test procedure under which UPSs would be tested in normal mode, the only mode that a UPS is in when connected to a power source, except in the rare occasions that it is in "charge mode." EPCA requires that any prescribed or amended test procedure shall be designed to produce test results which measure energy efficiency or energy use during a representative average use cycle or period of use. (42 U.S.C. 6293(b)(3)). As discussed in section III.B, a UPS is almost never in charge mode, and therefore measured energy for this mode would not be representative for a UPS in typical use as required by 42 U.S.C. 6293(b)(3). Thus, measuring the energy use of a UPS in normal mode effectively captures the energy used during the entirety of the time that a UPS is connected to mains power. As such, the test procedure proposed here incorporates measurement of energy use during active, standby, and off modes, as EPCA defines those terms.

DOE requests comment on the proposed output metric for UPSs.

I. Effective Date and Compliance of Test Procedure

If adopted, the effective date for this UPS test procedure would be 30 days after publication of the test procedure final rule in the Federal Register. At that time, the new metrics and any other measure of energy performance which depends on these metrics may be represented pursuant to the final rule. On or after 180 days after the date of publication of the test procedure final rule, any such

representations, including those made on marketing materials and product labels would be required to be based upon results generated under the final test procedure.

J. Sampling Plan for Determination of Certified Rating

For any covered product, manufacturers are required to determine the represented value, which includes the certified rating, for each basic model of the product in accordance with the DOE test procedure. Because today's proposed test procedure for UPSs and resulting metric differs from other battery chargers, DOE proposes that UPSs would certify the average load adjusted efficiency metric (Eff_{avg}) described in section III.H, as the representative value of efficiency for UPSs. In order to determine a rating for certifying compliance or making energy use representations, DOE typically requires manufacturers to test each basic model in accordance with the applicable DOE test procedure and apply the appropriate sampling plan. DOE proposes that the sampling provisions and certified rating requirements for battery chargers be applicable to UPSs.

K. Certification Reports

In addition to the requirements specified in 10 CFR 429.12, which are applicable to each basic model of a covered product, DOE proposes the following additional product specific public information be included in the battery charger certification report for UPSs in 10 CFR 429.39:

1. Active power, in Watts, and apparent power, in Volt-Amperes, of the UPS
2. Rated input and output voltage, in Volts, of the UPS
3. Efficiency at 25 percent, 50 percent, 75 percent, and 100 percent, and average normal mode loading efficiency of UPS

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

The Office of Management and Budget (OMB) has determined that test procedure rulemakings do not constitute "significant regulatory actions" under section 3(f) of Executive Order 12866, Regulatory Planning and Review, 58 FR 51735 (Oct. 4, 1993). Accordingly, this action was not subject to review under the Executive Order by the Office of Information and Regulatory Affairs (OIRA) in the Office of Management and Budget.

B. Review under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 et seq.) requires preparation of an initial regulatory flexibility analysis (IFRA) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, "Proper Consideration of Small Entities in Agency Rulemaking," 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the DOE rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website: http://energy.gov/gc/office-general-counsel.

DOE reviewed the test procedure considered in this proposed rule under the provisions of the Regulatory Flexibility Act (RFA) and the policies and procedures published on February 19, 2003.

DOE has concluded that the proposed rule would not have a significant impact on a substantial number of small entities. The factual basis for this certification is as follows.

The Small Business Administration (SBA) considers a business entity to be a small business, if, together with its affiliates, it employs less than a threshold number of workers specified in 13 CFR part 121. These size standards and codes are established by the North American Industry Classification System (NAICS). The threshold number for NAICS classification code 335999, which applies to "all other miscellaneous electrical equipment and component manufacturing" and includes UPSs, is 500 employees.

To estimate the number of companies that could be small business manufacturers of the equipment affected by this rulemaking, DOE conducted a market survey using available public information to identify potential small manufacturers. DOE's research involved reviewing the SBA database, marketing research tools (i.e., Hoover's reports), and company profiles on public websites (i.e., LinkedIn and Glassdoor) to create a list of all domestic small business manufacturers of battery chargers affected by this rulemaking. DOE identified 12 manufacturers of battery chargers as domestic small business manufacturers.

To determine the costs of the proposed test procedure on small manufacturers, DOE obtained quotations from two laboratories for testing UPSs and found the range to be from $1,400 to $2,000. While DOE performed the analysis using the highest quotation it received to estimate the maximum possible testing cost, DOE understands that a majority of UPS manufacturers are able to perform these tests with their own testing equipment. UPS manufacturers can significantly reduce testing costs by

conducting their own testing instead of using third party labs to test their products. Under the proposed test procedure, manufacturers would be required to test each UPS basic model individually; that is, a minimum of two units per basic model. DOE estimated the average number of basic models produced per manufacturer to be six. DOE determined the average number of basic models per manufacturer by examining product listings, product features, and model names from DOE's Compliance Database, EPA's ENERGY STAR,[3] and retailer websites to estimate the total number of basic models in the industry. DOE then divided the estimation by the total number of UPS manufacturers identified to find an average number of basic models per manufacturer. Therefore, to test two units of each basic model at a cost of $2,000 per unit, the average total cost of testing is $24,000 per manufacturer. From Hoovers, DOE estimated the average revenue of a small business manufacturer of battery chargers to be $22.2M. That is, the total cost of testing is approximately 0.11 percent of the average annual revenue.

Based on this analysis, DOE concludes that this proposed rule would not have a significant economic impact on a substantial number of small entities. DOE will provide its certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the SBA for review under 5 U.S.C. 605(b).

DOE seeks comment on whether the proposed test procedure changes will have a significant impact on a substantial number of small entities.

[3] ENERGY STAR. Energy Star Certified Products. Last accessed May 4, 2015. < http://www.energystar.gov/>.

C. Review Under the Paperwork Reduction Act of 1995

If DOE adopts energy conservation standards for battery chargers, manufacturers will be required to certify that their products comply with those standards. In certifying compliance, manufacturers must test their products according to the applicable DOE test procedure, including any amendments adopted for that test procedure. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, and is proposing specific requirements for battery chargers in this rule. See 10 CFR part 429, subpart B. The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910-1400. This information collection was renewed in January 2015 to include certification requirements for battery chargers. 80 FR 5099 (January 30, 2015). Public reporting burden for the certification is estimated to average 30 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Manufacturers would not be required to submit a certification report until such time as compliance with an energy conservation standard is required.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

In this proposed rule, DOE proposes test procedure amendments that it expects will be used to develop and implement future energy conservation standards for UPSs. DOE has determined that this rule falls into a class of actions that are categorically excluded from review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) and DOE's implementing regulations at 10 CFR part 1021. Specifically, this proposed rule would amend the existing test procedures without affecting the amount, quality or distribution of energy usage, and, therefore, would not result in any environmental impacts. Thus, this rulemaking is covered by Categorical Exclusion A5 under 10 CFR part 1021, subpart D, which applies to any rulemaking that interprets or amends an existing rule without changing the environmental effect of that rule. Accordingly, neither an environmental assessment nor an environmental impact statement is required.

E. Review Under Executive Order 13132

Executive Order 13132, "Federalism," 64 FR 43255 (August 4, 1999) imposes certain requirements on agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this proposed rule and has determined that it would not have a substantial direct effect on the States, on the relationship

between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of this proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297(d)) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

Regarding the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, "Civil Justice Reform," 61 FR 4729 (Feb. 7, 1996), imposes on Federal agencies the general duty to adhere to the following requirements: (1) eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; (3) provide a clear legal standard for affected conduct rather than a general standard; and (4) promote simplification and burden reduction. Section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in sections 3(a) and 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, the proposed rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Pub. L. No. 104-4, sec. 201 (codified at 2 U.S.C. 1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820; also available at http://energy.gov/gc/office-general-counsel. DOE examined this proposed rule according to UMRA and its statement of policy and determined that the rule contains neither an intergovernmental mandate, nor a mandate that may result in the expenditure of $100 million or more in any year, so these requirements do not apply.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105-277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This rule would not have any impact on the autonomy or integrity of the family as an

institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

DOE has determined, under Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights" 53 FR 8859 (March 18, 1988), that this regulation would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed this proposed rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use," 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OMB, a Statement of Energy Effects for any proposed significant energy action. A "significant energy action" is defined as any action by an agency that promulgated or is expected to lead to promulgation of a final rule, and that: (1) is a significant regulatory action under Executive Order

12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy; or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

The proposed regulatory action to amend the test procedure for measuring the energy efficiency of UPSs is not a significant regulatory action under Executive Order 12866. Moreover, it would not have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as a significant energy action by the Administrator of OIRA. Therefore, it is not a significant energy action, and, accordingly, DOE has not prepared a Statement of Energy Effects.

L. Review Under Section 32 of the Federal Energy Administration Act of 1974

Under section 301 of the Department of Energy Organization Act (Pub. L. 95–91; 42 U.S.C. 7101), DOE must comply with section 32 of the Federal Energy Administration Act of 1974, as amended by the Federal Energy Administration Authorization Act of 1977. (15 U.S.C. 788; FEAA) Section 32 essentially provides in relevant part that, where a proposed rule authorizes or requires use of commercial standards, the notice of proposed rulemaking must inform the public of the use and background of such standards. In addition, section 32(c) requires DOE to consult with the Attorney General and the Chairman of the Federal Trade Commission (FTC) concerning the impact of the commercial or industry standards on competition.

This proposed rule incorporates testing methods contained in Section 6 and Annex J of the IEC 62040-3 Ed. 2.0, "Uninterruptible power systems (UPS) – Method of specifying the performance and test requirements" standard. DOE has evaluated this standard and is unable to conclude whether it fully complies with the requirements of section 32(b) of the FEAA, (i.e., that they were developed in a manner that fully provides for public participation, comment, and review). DOE will consult with the Attorney General and the Chairman of the FTC concerning the impact of these test procedures on competition, prior to prescribing a final rule.

M. Description of Material Incorporated by Reference

The proposed rule incorporates Section 6 and Annex J of the IEC 62040-3 Ed. 2.0, "Uninterruptible power systems (UPS) – Method of specifying the performance and test requirements" standard. This standard is used to specify the testing requirements for UPSs and is available from the American National Standards Institute, 25 W. 43rd Street, 4th Floor, New York, NY 10036 or at http://webstore.ansi.org/.

V. Public Participation

A. Attendance at Public Meeting

The time, date and location of the public meeting are listed in the DATES and ADDRESSES sections at the beginning of this document. If you plan to attend the public meeting, please notify Ms. Brenda Edwards at (202) 586-2945 or Brenda.Edwards@ee.doe.gov.

Please note that foreign nationals visiting DOE Headquarters are subject to advance security screening procedures which require advance notice prior to attendance at the public meeting. If a foreign national wishes to participate in the public meeting, please inform DOE of this fact as soon as possible by contacting Ms. Regina Washington at (202) 586-1214 or by e-mail: Regina.Washington@ee.doe.gov so that the necessary procedures can be completed.

DOE requires visitors to have laptops and other devices, such as tablets, checked upon entry into the building. Any person wishing to bring these devices into the Forrestal Building will be required to obtain a property pass. Visitors should avoid bringing these devices, or allow an extra 45 minutes to check in. Please report to the visitor's desk to have devices checked before proceeding through security.

Due to the REAL ID Act implemented by the Department of Homeland Security (DHS), there have been recent changes regarding ID requirements for individuals wishing to enter Federal buildings from specific states and U.S. territories. Driver's licenses from the following states or territory will not be accepted for building entry and one of the alternate forms of ID listed below will be required. DHS has determined that regular driver's licenses (and ID cards) from the following jurisdictions are not acceptable for entry into DOE facilities: Alaska, American Samoa, Arizona, Louisiana, Maine, Massachusetts, Minnesota, New York, Oklahoma, and Washington. Acceptable alternate forms of Photo-ID include: U.S. Passport or Passport Card; an Enhanced Driver's License or Enhanced ID-Card issued by the states of Minnesota, New York or Washington (Enhanced licenses issued by these states are clearly marked Enhanced or Enhanced Driver's License); a military ID or other Federal government issued Photo-ID card.

In addition, you can attend the public meeting via webinar. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website: https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=26&action=viewlive. Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Procedure for Submitting Prepared General Statements for Distribution

Any person who has plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the ADDRESSES section at the beginning of this notice. The request and advance copy of statements must be received at least one week before the public meeting and may be emailed, hand-delivered, or sent by mail. DOE prefers to receive requests and advance copies via email. Please include a telephone number to enable DOE staff to make a follow-up contact, if needed.

C. Conduct of Public Meeting

DOE will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA (42 U.S.C. 6306). A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public

meeting. After the public meeting and until the end of the comment period, interested parties may submit further comments on the proceedings and any aspect of the rulemaking.

The public meeting will be conducted in an informal, conference style. DOE will present summaries of comments received before the public meeting, allow time for prepared general statements by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant will be allowed to make a general statement (within time limits determined by DOE), before the discussion of specific topics. DOE will permit, as time permits, other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the public meeting.

A transcript of the public meeting will be included in the docket, which can be viewed as described in the Docket section at the beginning of this notice. In addition, any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

DOE will accept comments, data, and information regarding this proposed rule before or after the public meeting, but no later than the date provided in the DATES section at the beginning of this proposed rule. Interested parties may submit comments using any of the methods described in the ADDRESSES section at the beginning of this proposed rule.

Submitting comments via regulations.gov. The regulations.gov web page will require you to provide your name and contact information. Your contact information will be viewable to DOE Building Technologies staff only. Your contact information will not be publicly viewable except for your first and last names, organization name (if any), and submitter representative name (if any). If your comment is not processed properly because of technical difficulties, DOE will use this information to contact you. If DOE cannot read your comment due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

Do not submit to regulations.gov information for which disclosure is restricted by statute, such as trade secrets and commercial or financial information (hereinafter referred to as Confidential Business Information (CBI)). Comments submitted through regulations.gov cannot be claimed as CBI.

Comments received through the website will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section.

DOE processes submissions made through regulations.gov before posting. Normally, comments will be posted within a few days of being submitted. However, if large volumes of comments are being processed simultaneously, your comment may not be viewable for up to several weeks. Please keep the comment tracking number that regulations.gov provides after you have successfully uploaded your comment.

Submitting comments via email, hand delivery, or mail. Comments and documents submitted via email, hand delivery, or mail also will be posted to regulations.gov. If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information on a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. The cover letter will not be publicly viewable as long as it does not include any comments

Include contact information each time you submit comments, data, documents, and other information to DOE. If you submit via mail or hand delivery, please provide all items on a CD, if feasible. It is not necessary to submit printed copies. No facsimiles (faxes) will be accepted.

Comments, data, and other information submitted to DOE electronically should be provided in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format. Provide documents that are not secured, written in English and free of any defects or viruses. Documents should

not contain special characters or any form of encryption and, if possible, they should carry the electronic signature of the author.

Campaign form letters. Please submit campaign form letters by the originating organization in batches of between 50 to 500 form letters per PDF or as one form letter with a list of supporters' names compiled into one or more PDFs. This reduces comment processing and posting time.

Confidential Business Information. According to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email, postal mail, or hand delivery two well-marked copies: one copy of the document marked confidential including all the information believed to be confidential, and one copy of the document marked non-confidential with the information believed to be confidential deleted. Submit these documents via email or on a CD, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include: (1) A description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

It is DOE's policy that all comments may be included in the public docket, without change and as received, including any personal information provided in the comments (except information deemed to be exempt from public disclosure).

E. Issues on Which DOE Seeks Comment

Although DOE welcomes comments on any aspect of this proposal, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

1. DOE requests comment on the proposal to include specific test provisions for UPSs in the battery charger test procedure. See section III.A for further detail.

2. DOE requests stakeholder comments on the type of changes that are being considered for the revised IEC 62040-3 standard and how it may impact the test procedure proposed today. See section III.B for further detail.

3. DOE requests comment on all proposed definitions, particularly those that are not defined in existing industry standards. See section III.C for further detail.

4. DOE requests comment on the proposed test conditions. See section III.D for further detail.

5. DOE requests comment on the proposed two different methods of calculating average power. DOE requests comment on the comparability of the results from the two methods. See

section III.G for further detail.

6. DOE requests comment on the proposed output metric for UPSs. See section III.H for further detail.

7. DOE seeks comment on whether the proposed test procedure changes will have a significant impact on a substantial number of small entities. See section IV.B for further detail.

VI. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this proposed rule.

List of Subjects

10 CFR Part 429

Confidential business information, Energy conservation, Household appliances, Imports, Reporting and recordkeeping requirements.

10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Incorporation by reference, Intergovernmental relations, Small businesses.

Issued in Washington, DC, on April 29, 2016.

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Kathleen B. Hogan
Deputy Assistant Secretary for Energy Efficiency
Energy Efficiency and Renewable Energy

For the reasons stated in the preamble, DOE is proposing to amend parts 429 and 430 of chapter II of title 10, subchapter D of the Code of Federal Regulations as set forth below:

PART 429—CERTIFICATION, COMPLIANCE, AND ENFORCEMENT FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT

1. The authority citation for part 429 continues to read as follows:

Authority: 42 U.S.C. 6291-6317.

2. Revise § 429.39 to read as follows:

§ 429.39 Battery chargers.

(a) *Determination of represented value.* Manufacturers must determine a represented value, which includes the certified rating, for each basic model of battery charger in accordance with the following sampling provisions.

(1) *Represented values include*: Battery discharge energy in watt hours (Wh), 24-hour energy consumption in watt hours (Wh), maintenance mode power in watts (W), standby mode power in watts (W), and off mode power in watts (W) for all battery chargers other than UPSs; and average load adjusted efficiency (Eff_{avg}) for UPSs.

(2) *Units to be tested.* (i) The general requirements of § 429.11 are applicable to battery chargers; and

(ii) For each basic model, a sample of sufficient size must be randomly selected and tested to ensure that—

(A) Any represented value of annual energy consumption, power, or other measure of energy use of a basic model for which consumers would favor lower values is greater than or equal to the higher of:

(*1*) The mean of the sample, where:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

And, $\bar{x}$ is the sample mean; *n* is the number of samples; and x_i is the *i*th sample; or,

(*2*) The upper 97.5-percent confidence limit (UCL) of the true mean divided by 1.05, where:

$$UCL = \bar{x} + t_{0.975}\left(\frac{s}{\sqrt{n}}\right)$$

And $\bar{x}$ is the sample mean; *s* is the sample standard deviation; *n* is the number of samples; and $t_{0.975}$ is the t-statistic for a 97.5-percent one-tailed confidence interval with n-1 degrees of freedom (from appendix A of this subpart). And,

(B) Any represented value of energy efficiency or other measure of energy consumption of a basic model for which consumers would favor higher values is less than or equal to the lower of:

(*1*) The mean of the sample, where:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

And, $\bar{x}$ is the sample mean; *n* is the number of samples; and x_i is the *i*th sample; or,

(*2*) The lower 97.5-percent confidence limit (LCL) of the true mean divided by 0.95, where:

$$LCL = \bar{x} - t_{0.975}\left(\frac{s}{\sqrt{n}}\right)$$

And $\bar{x}$ is the sample mean; *s* is the sample standard deviation; *n* is the number of samples; and $t_{0.975}$ is the t-statistic for a 97.5-percent one-tailed confidence interval with n-1 degrees of freedom (from appendix A of this subpart).

(b) *Certification reports*. (1) The requirements of § 429.12 are applicable to battery chargers.

(2) Pursuant to § 429.12(b)(13), a certification report must include the following public product-specific information for all battery chargers other than UPSs: The manufacturer and model of the test battery, the nameplate battery voltage of the test battery in volts (V), the nameplate charge capacity of the test battery in ampere-hours (Ah), the nameplate charge energy, if available, of the battery in watt hours (Wh), the manufacturer and model, when applicable, of the external power supply used for testing; the average duration of the charge and maintenance mode test in hours (hr) for the units sampled; battery discharge energy in watt hours (Wh); 24-hour energy consumption in watt hours (Wh); maintenance mode power in watts (W); standby mode power in watts (W); and off made power in watts (W). For UPSs, a certification report must include the following public product-specific information: active power in watts (W); apparent power in volt-amperes (VA); rated input and output voltages in volts (V); efficiencies at 25 percent, 50 percent, 75 percent and 100 percent of the reference test load; and average normal mode efficiency.

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

3. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

4. Section 430.3 is amended, as amended at 81 FR 25600 (April 29, 2016), effective May 31, 2016, by:

a. Redesignating paragraphs (p)(3) through (p)(5) as paragraphs (p)(4) through (p)(6) respectively; and

b. Adding new paragraph (p)(3) to read as follows:

§ 430.3 Materials incorporated by reference.

* * * * *

(p) * * *

(3) IEC Standard 62040-3 Ed. 2.0, (‘‘IEC 62040-3 Ed. 2.0”), *Uninterruptible Power Systems (UPS) – Part 3: Method of Specifying the Performance and Test Requirements,* Edition 2.0, Section 6 “UPS tests,” and Annex J “UPS efficiency,” March 2011, IBR approved for appendix Y to subpart B.

* * * * *

5. Section 430.23(aa) is revised to read as follows:

§ 430.23 Test procedures for the measurement of energy and water consumption.

* * * * *

(aa) *Battery chargers.* Measure the energy consumption or energy efficiency of a battery charger in accordance with appendix Y to this subpart.

* * * * *

6. Appendix Y to subpart B of part 430 is amended by:

a. Revising section 1, Scope;

b. Amending section 2 as follows:

1. Redesignating section 2.24 as section 2.28;

2. Adding a new section 2.24;

3. Redesignating sections 2.22 and 2.23 as sections 2.25 and 2.26, respectively;

4. Adding sections 2.27, 2.27.1, 2.27.2, and 2.27.3;

5. Redesignating sections 2.18 through 2.21 as sections 2.20 through 2.23, respectively;

6. Adding a new section 2.19;

7. Redesignating sections 2.12 through 2.17 as sections 2.13 through 2.18, respectively;

8. Adding a new section 2.12;

c. Revising sections 3 and 4; and

d. Removing section 5.

The additions and revisions read as follows:

Appendix Y to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Battery Chargers

*** * * * ***

1. SCOPE

This appendix covers the testing requirements used to measure the energy consumption for battery chargers operating at either DC or United States AC line voltage (115V at 60Hz). This appendix also covers the testing requirements used to measure the energy efficiency for uninterruptible power supplies as defined in section 2 of this appendix with an AC output.

*** * * * ***

2. DEFINITIONS

* * * * *

2.12. *Energy storage system* is a system consisting of single or multiple devices designed to provide power to the UPS inverter circuitry.

* * * * *

2.19. *Normal mode* is a mode of operation for a UPS in which:

(1) The UPS provides required output power to the connected load without switching to battery power,

(2) The energy storage system is being maintained at full charge, and

(3) The load connected to the UPS is within the UPS's specified power rating.

* * * * *

2.24. *Reference test load* is a load or a condition with a power factor of greater than 0.99 in which the AC output socket of the UPS delivers the active power (W) for which the UPS is rated.

* * * * *

2.27. *Uninterruptible power supply* or *UPS* means a battery charger consisting of a combination of convertors, switches and energy storage devices, constituting a power system for maintaining continuity of load power in case of input power failure.

2.27.1. *Voltage and frequency dependent UPS* or *VFD UPS* means a UPS that produces an AC output where the output voltage and frequency are dependent on the input voltage and frequency. This UPS architecture does not provide corrective functions like those in voltage independent and voltage and frequency independent systems.

Note to 2.27.1: VFD input dependency may be verified by performing the AC input failure test in section 6.2.2.7 of IEC 62040-3 Ed. 2.0 (incorporated by reference, see § 430.3 of this chapter) and

observing that, at a minimum, the UPS switches from normal mode of operation to battery power while the input is interrupted.

2.27.2. *Voltage and frequency independent UPS* or *VFI UPS* means a UPS where the device remains in normal mode producing an AC output voltage and frequency that is independent of input voltage and frequency variations and protects the load against adverse effects from such variations without depleting the stored energy source. The input voltage and frequency variations through which the UPS must remain in normal mode is as follows:

(1) ± 10 % of the rated input voltage or the tolerance range specified by the manufacturer, whichever is greater; and

(2) ± 2 % of the rated input frequency or the tolerance range specified by the manufacturer, whichever is greater."

Note to 2.27.2: VFI input dependency may be verified by performing the steady state input voltage tolerance test and the input frequency tolerance test in sections 6.4.1.1 and 6.4.1.2 of IEC 62040-3 Ed. 2.0 (incorporated by reference, see § 430.3 of this chapter) respectively and observing that, at a minimum, the output voltage and frequency remain within the specified output tolerance band during the test.

2.27.3. *Voltage independent UPS* or *VI UPS* means a UPS that produces an AC output within a specific tolerance band that is independent of under-voltage or over-voltage variations in the input voltage. The output frequency of a VI UPS is dependent on the input frequency, similar to a voltage and frequency dependent system.

Note to 2.27.3: VI input dependency may be verified by performing the steady state input voltage tolerance test in section 6.4.1.1 of IEC 62040-3 Ed. 2.0 (incorporated by reference, see § 430.3 of this chapter) and observing that the output voltage remains within the specified limit during the test.

* * * * *

3. Testing Requirements for all Battery Chargers other than Uninterruptible Power Supplies

3.1. Standard Test Conditions

3.1.1 General. The values that may be measured or calculated during the conduct of this test procedure have been summarized for easy reference in Table 3.1.1 of this appendix.

Table 3.1.1— List of Measured or Calculated Values

Name of measured or calculated value	**Reference**
1. Duration of the charge and maintenance mode test	Section 3.3.2
2. Battery Discharge Energy	Section 3.2.6
3. Initial time and power (W) of the input current of connected battery	Section 3.3.8
4. Active and Maintenance Mode Energy Consumption	Section 3.3.8
5. Maintenance Mode Power	Section 3.3.9
6. 24 Hour Energy Consumption	Section 3.3.10
7. Standby Mode Power	Section 3.3.11
8. Off Mode Power	Section 3.3.12

3.1.2. Verifying Accuracy and Precision of Measuring Equipment

(a) Measurements of active power of 0.5 W or greater shall be made with an uncertainty of ≤2 percent at the 95 percent confidence level. Measurements of active power of less than 0.5 W shall be made with an uncertainty of ≤0.01 W at the 95 percent confidence level. The power measurement instrument shall, as applicable, have a resolution of:

(1) 0.01 W or better for measurements up to 10 W;

(2) 0.1 W or better for measurements of 10 to 100 W; or

(3) 1 W or better for measurements over 100 W.

(b) Measurements of energy (Wh) shall be made with an uncertainty of ≤2 percent at the 95 percent confidence level. Measurements of voltage and current shall be made with an uncertainty of ≤1 percent at the 95 percent confidence level. Measurements of temperature shall be made with an uncertainty of ≤2 °C at the 95 percent confidence level.

(c) All equipment used to conduct the tests must be selected and calibrated to ensure that measurements will meet the above uncertainty requirements. For suggestions on measuring low power levels, see IEC 62301, (Reference for guidance only, see § 430.4 of this chapter) especially section 5.3.2 and Annexes B and D.

3.1.3. Setting Up the Test Room. All tests, battery conditioning, and battery rest periods shall be carried out in a room with an air speed immediately surrounding the UUT of ≤0.5 m/s. The ambient temperature shall be maintained at 20 °C ±5 °C throughout the test. There shall be no intentional cooling of the UUT such as by use of separately powered fans, air conditioners, or heat sinks. The UUT shall be conditioned,

rested, and tested on a thermally non-conductive surface. When not undergoing active testing, batteries shall be stored at 20 °C ±5 °C.

3.1.4. Verifying the UUT's Input Voltage and Input Frequency

(a) If the UUT is intended for operation on AC line-voltage input in the United States, it shall be tested at 115 V at 60 Hz. If the UUT is intended for operation on AC line-voltage input but cannot be operated at 115 V at 60 Hz, it shall not be tested.

(b) If a charger is powered by a low-voltage DC or AC input, and the manufacturer packages the charger with a wall adapter, sells, or recommends an optional wall adapter capable of providing that low voltage input, then the charger shall be tested using that wall adapter and the input reference source shall be 115 V at 60 Hz. If the wall adapter cannot be operated with AC input voltage at 115 V at 60 Hz, the charger shall not be tested.

(c) If the UUT is designed for operation only on DC input voltage and the provisions of section 3.1.4(b) of this appendix do not apply, it shall be tested with one of the following input voltages: 5.0 V DC for products drawing power from a computer USB port or the midpoint of the rated input voltage range for all other products. The input voltage shall be within ±1 percent of the above specified voltage.

(d) If the input voltage is AC, the input frequency shall be within ±1 percent of the specified frequency. The THD of the input voltage shall be ≤2 percent, up to and including the 13th harmonic. The crest factor of the input voltage shall be between 1.34 and 1.49.

(e) If the input voltage is DC, the AC ripple voltage (RMS) shall be:

(1) ≤0.2 V for DC voltages up to 10 V; or

(2) ≤2 percent of the DC voltage for DC voltages over 10 V.

3.2. UNIT UNDER TEST SETUP REQUIREMENTS

3.2.1. General Setup

(a) The battery charger system shall be prepared and set up in accordance with the manufacturer's instructions, except where those instructions conflict with the requirements of this test procedure. If no instructions are given, then factory or "default" settings shall be used, or where there are no indications of such settings, the UUT shall be tested in the condition as it would be supplied to an end user.

(b) If the battery charger has user controls to select from two or more charge rates (such as regular or fast charge) or different charge currents, the test shall be conducted at the fastest charge rate that is recommended by the manufacturer for everyday use, or, failing any explicit recommendation, the factory-default charge rate. If the charger has user controls for selecting special charge cycles that are recommended only for occasional use to preserve battery health, such as equalization charge, removing memory, or battery conditioning, these modes are not required to be tested. The settings of the controls shall be listed in the report for each test.

3.2.2. Selection and Treatment of the Battery Charger. The UUT, including the battery charger and its associated battery, shall be new products of the type and condition that would be sold to a customer. If the battery is lead-acid chemistry and the battery is to be stored for more than 24 hours between its initial acquisition and testing, the battery shall be charged before such storage.

3.2.3. Selection of Batteries To Use for Testing

(a) For chargers with integral batteries, the battery packaged with the charger shall be used for testing. For chargers with detachable batteries, the battery or batteries to be used for testing will vary depending on whether there are any batteries packaged with the battery charger.

(1) If batteries are packaged with the charger, batteries for testing shall be selected from the batteries packaged with the battery charger, according to the procedure in section 3.2.3(b) of this appendix.

(2) If no batteries are packaged with the charger, but the instructions specify or recommend batteries for use with the charger, batteries for testing shall be selected from those recommended or specified in the instructions, according to the procedure in section 3.2.3(b) of this appendix.

(3) If no batteries are packaged with the charger and the instructions do not specify or recommend batteries for use with the charger, batteries for testing shall be selected from any that are suitable for use with the charger, according to the procedure in section 3.2.3(b) of this appendix.

(b) From the detachable batteries specified in section 3.2.3(a), the technician shall use Table 3.2.1 of this appendix to select the batteries to be used for testing depending on the type of charger being tested. Each row in the table represents a mutually exclusive charger type. The technician shall find the single applicable row for the UUT, and test according to those requirements.

(c) A charger is considered as:

(1) Single-capacity if all associated batteries have the same rated charge capacity (see section 2.22) and, if it is a batch charger, all configurations of the batteries have the same rated charge capacity.

(2) Multi-capacity if there are associated batteries or configurations of batteries that have different rated charge capacities.

(d) The selected battery or batteries will be referred to as the "test battery" and will be used through the remainder of this test procedure.

TABLE 3.2.1—BATTERY SELECTION FOR TESTING

Type of charger			**Tests to perform**	
Multi-voltage	**Multi-port**	**Multi-capacity**	**Number of tests**	**Battery selection (from all configurations of all associated batteries)**
No	No	No	1	Any associated battery.
No	No	Yes	2	Lowest charge capacity battery. Highest charge capacity battery.
No	Yes	Yes or No	2	Use only one port and use the minimum number of batteries with the lowest rated charge capacity that the charger can charge. Use all ports and use the maximum number of identical batteries of the highest rated charge capacity the charger can accommodate.
Yes	No	No	2	Lowest voltage battery. Highest voltage battery.
Yes	Yes to either or both		3	Of the batteries with the lowest voltage, use the one with the lowest charge capacity. Use only one port. Of the batteries with the highest voltage, use the one with the lowest charge capacity. Use only one port. Use all ports and use the battery or the configuration of batteries with the highest total rated energy capacity.

3.2.4. Limiting Other Non-Battery-Charger Functions

(a) If the battery charger or product containing the battery charger does not have any additional functions unrelated to battery charging, this subsection may be skipped.

(b) Any optional functions controlled by the user and not associated with the battery charging process (*e.g.,* the answering machine in a cordless telephone charging base) shall be switched off. If it is not possible to switch such functions off, they shall be set to their lowest power-consuming mode during the test.

(c) If the battery charger takes any physically separate connectors or cables not required for battery charging but associated with its other functionality (such as phone lines, serial or USB connections, Ethernet, cable TV lines, *etc.*), these connectors or cables shall be left disconnected during the testing.

(d) Any manual on-off switches specifically associated with the battery charging process shall be switched on for the duration of the charge, maintenance, and no-battery mode tests, and switched off for the off mode test.

3.2.5. Accessing the Battery for the Test

(a) The technician may need to disassemble the end-use product or battery charger to gain access to the battery terminals for the Battery Discharge Energy Test in section 3.3.6 of this appendix. If the battery terminals are not clearly labeled, the technician shall use a voltmeter to identify the positive and negative terminals. These terminals will be the ones that give the largest voltage difference and are able to deliver significant current (0.2 C or 1/hr) into a load.

(b) All conductors used for contacting the battery must be cleaned and burnished prior to connecting in order to decrease voltage drops and achieve consistent results.

(c) Manufacturer's instructions for disassembly shall be followed, except those instructions that:

(1) Lead to any permanent alteration of the battery charger circuitry or function;

(2) Could alter the energy consumption of the battery charger compared to that experienced by a user during typical use, *e.g.,* due to changes in the airflow through the enclosure of the UUT; or

(3) Conflict requirements of this test procedure.

(d) Care shall be taken by the technician during disassembly to follow appropriate safety precautions. If the functionality of the device or its safety features is compromised, the product shall be discarded after testing.

(e) Some products may include protective circuitry between the battery cells and the remainder of the device. If the manufacturer provides a description for accessing the connections at the output of the protective circuitry, these connections shall be used to discharge the battery and measure the discharge energy. The energy consumed by the protective circuitry during discharge shall not be measured or credited as battery energy.

(f) If the technician, despite diligent effort and use of the manufacturer's instructions, encounters any of the following conditions noted immediately below, the Battery Discharge Energy and the Charging and Maintenance Mode Energy shall be reported as "Not Applicable":

(1) Inability to access the battery terminals;

(2) Access to the battery terminals destroys charger functionality; or

(3) Inability to draw current from the test battery.

3.2.6. Determining Charge Capacity for Batteries With No Rating.

(a) If there is no rating for the battery charge capacity on the battery or in the instructions, then the technician shall determine a discharge current that meets the following requirements. The battery shall be fully charged and then discharged at this constant-current rate until it reaches the end-of-discharge voltage specified in Table 3.3.2 of this appendix. The discharge time must be not less than 4.5 hours nor more than 5 hours. In addition, the discharge test (section 3.3.6 of this appendix) (which may not be starting with a fully-charged battery) shall reach the end-of-discharge voltage within 5 hours. The same discharge current shall be used for both the preparations step (section 3.3.4 of this appendix) and the discharge test (section 3.3.6 of this appendix). The test report shall include the discharge current used and the resulting discharge times for both a fully-charged battery and for the discharge test.

(b) For this section, the battery is considered as "fully charged" when either: it has been charged by the UUT until an indicator on the UUT shows that the charge is complete; or it has been charged by a battery analyzer at a current not greater than the discharge current until the battery analyzer indicates that the battery is fully charged.

(c) When there is no capacity rating, a suitable discharge current must generally be determined by trial and error. Since the conditioning step does not require constant-current discharges, the trials themselves may also be counted as part of battery conditioning.

3.3. TEST MEASUREMENT

The test sequence to measure the battery charger energy consumption is summarized in Table 3.3.1 of this appendix, and explained in detail below. Measurements shall be made under test conditions and with the equipment specified in sections 3.1 and 3.2 of this appendix.

TABLE 3.3.1—TEST SEQUENCE

Step	Description	Data taken?	Equipment needed				
			Test battery	Charger	Battery analyzer or constant-current load	AC power meter	Thermometer (for flooded lead-acid battery chargers only)
1	Record general data on UUT; Section 3.3.1	Yes	X	X			
2	Determine test duration; Section 3.3.2	No					
3	Battery conditioning; Section 3.3.3	No	X	X	X		
4	Prepare battery for charge test; Section 3.3.4	No	X	X			
5	Battery rest period; Section 3.3.5	No	X				X
6	Conduct Charge Mode and Battery Maintenance Mode Test; Section 3.3.6	Yes	X	X		X	
7	Battery Rest Period; Section 3.3.7	No	X				X
8	Battery Discharge Energy Test; Section 3.3.8	Yes	X		X		
9	Determining the Maintenance Mode Power; Section 3.3.9	Yes	X	X		X	
10	Calculating the 24-Hour Energy Consumption; Section 3.3.10	No					
11	Standby Mode Test; Section 3.3.11	Yes		X		X	
12	Off Mode Test; Section 3.3.12	Yes		X		X	

3.3.1. Recording General Data on the UUT. The technician shall record:

(a) The manufacturer and model of the battery charger;

(b) The presence and status of any additional functions unrelated to battery charging;

(c) The manufacturer, model, and number of batteries in the test battery;

(d) The rated battery voltage of the test battery;

(e) The rated charge capacity of the test battery; and

(f) The rated charge energy of the test battery.

(g) The settings of the controls, if battery charger has user controls to select from two or more charge rates

3.3.2. Determining the Duration of the Charge and Maintenance Mode Test

(a) The charging and maintenance mode test, described in detail in section 3.3.8 of this appendix, shall be 24 hours in length or longer, as determined by the items below. Proceed in order until a test duration is determined.

(1) If the battery charger has an indicator to show that the battery is fully charged, that indicator shall be used as follows: If the indicator shows that the battery is charged after 19 hours of charging, the test shall be terminated at 24 hours. Conversely, if the full-charge indication is not yet present after 19 hours of charging, the test shall continue until 5 hours after the indication is present.

(2) If there is no indicator, but the manufacturer's instructions indicate that charging this battery or this capacity of battery should be complete within 19 hours, the test shall be for 24 hours. If the instructions indicate that charging may take longer than 19 hours, the test shall be run for the longest estimated charge time plus 5 hours.

(3) If there is no indicator and no time estimate in the instructions, but the charging current is stated on the charger or in the instructions, calculate the test duration as the longer of 24 hours or:

$$Duration = 1.4 \cdot \frac{RatedChargeCapacity\,(\mathrm{Ah})}{ChargeCurrent\,(\mathrm{A})} + 5\mathrm{h}$$

(b) If none of the above applies, the duration of the test shall be 24 hours.

3.3.3. Battery Conditioning

(a) No conditioning is to be done on lead-acid or lithium-ion batteries. The test technician shall proceed directly to battery preparation, section 3.3.4 of this appendix, when testing chargers for these batteries.

(b) Products with integral batteries will have to be disassembled per the instructions in section 3.2.5 of this appendix, and the battery disconnected from the charger for discharging.

(c) Batteries of other chemistries that have not been previously cycled are to be conditioned by performing two charges and two discharges, followed by a charge, as below. No data need be recorded during battery conditioning.

(1) The test battery shall be fully charged for the duration specified in section 3.3.2 of this appendix or longer using the UUT.

(2) The test battery shall then be fully discharged using either:

(i) A battery analyzer at a rate not to exceed 1 C, until its average cell voltage under load reaches the end-of-discharge voltage specified in Table 3.3.2 of this appendix for the relevant battery chemistry; or

(ii) The UUT, until the UUT ceases operation due to low battery voltage.

(3) The test battery shall again be fully charged as in step (c)(1) of this section.

(4) The test battery shall again be fully discharged as per step (c)(2) of this section.

(5) The test battery shall be again fully charged as in step (c)(1) of this section.

(d) Batteries of chemistries other than lead-acid or lithium-ion that are known to have been through at least two previous full charge/discharge cycles shall only be charged once per step (c)(5), of this section.

3.3.4. Preparing the Battery for Charge Testing. Following any conditioning prior to beginning the battery charge test (section 3.3.6 of this appendix), the test battery shall be fully discharged for the duration specified in section 3.3.2 of this appendix, or longer using a battery analyzer.

3.3.5. Resting the Battery. The test battery shall be rested between preparation and the battery charge test. The rest period shall be at least one hour and not exceed 24 hours. For batteries with flooded cells, the electrolyte temperature shall be less than 30 °C before charging, even if the rest period must be extended longer than 24 hours.

3.3.6. Testing Charge Mode and Battery Maintenance Mode

(a) The Charge and Battery Maintenance Mode test measures the energy consumed during charge mode and some time spent in the maintenance mode of the UUT. Functions required for battery conditioning that happen only with some user-selected switch or other control shall not be included in this measurement. (The technician shall manually turn off any battery conditioning cycle or setting.) Regularly occurring battery conditioning or maintenance functions that are not controlled by the user will, by default, be incorporated into this measurement.

(b) During the measurement period, input power values to the UUT shall be recorded at least once every minute.

(1) If possible, the technician shall set the data logging system to record the average power during the sample interval. The total energy is computed as the sum of power samples (in watts) multiplied by the sample interval (in hours).

(2) If this setting is not possible, then the power analyzer shall be set to integrate or accumulate the input power over the measurement period and this result shall be used as the total energy.

(c) The technician shall follow these steps:

(1) Ensure that the user-controllable device functionality not associated with battery charging and any battery conditioning cycle or setting are turned off, as instructed in section 3.2.4 of this appendix;

(2) Ensure that the test battery used in this test has been conditioned, prepared, discharged, and rested as described in sections 3.3.3 through 3.3.7 of this appendix;

(3) Connect the data logging equipment to the battery charger;

(4) Record the start time of the measurement period, and begin logging the input power;

(5) Connect the test battery to the battery charger within 3 minutes of beginning logging. For integral battery products, connect the product to a cradle or wall adapter within 3 minutes of beginning logging;

(6) After the test battery is connected, record the initial time and power (W) of the input current to the UUT. These measurements shall be taken within the first 10 minutes of active charging;

(7) Record the input power for the duration of the "Charging and Maintenance Mode Test" period, as determined by section 3.3.2 of this appendix. The actual time that power is connected to the UUT shall be within ±5 minutes of the specified period; and

(8) Disconnect power to the UUT, terminate data logging, and record the final time.

3.3.7. Resting the Battery. The test battery shall be rested between charging and discharging. The rest period shall be at least 1 hour and not more than 4 hours, with an exception for flooded cells. For batteries with flooded cells, the electrolyte temperature shall be less than 30 °C before charging, even if the rest period must be extended beyond 4 hours.

3.3.8. Battery Discharge Energy Test

(a) If multiple batteries were charged simultaneously, the discharge energy is the sum of the discharge energies of all the batteries.

(1) For a multi-port charger, batteries that were charged in separate ports shall be discharged independently.

(2) For a batch charger, batteries that were charged as a group may be discharged individually, as a group, or in sub-groups connected in series and/or parallel. The position of each battery with respect to the other batteries need not be maintained.

(b) During discharge, the battery voltage and discharge current shall be sampled and recorded at least once per minute. The values recorded may be average or instantaneous values.

(c) For this test, the technician shall follow these steps:

(1) Ensure that the test battery has been charged by the UUT and rested according to the procedures above.

(2) Set the battery analyzer for a constant discharge current of 0.2 °C and the end-of-discharge voltage in Table 3.3.2 of this appendix for the relevant battery chemistry.

(3) Connect the test battery to the analyzer and begin recording the voltage, current, and wattage, if available from the battery analyzer. When the end-of-discharge voltage is reached or the UUT circuitry terminates the discharge, the test battery shall be returned to an open-circuit condition. If current continues to be drawn from the test battery after the end-of-discharge condition is first reached, this additional energy is not to be counted in the battery discharge energy.

(d) If not available from the battery analyzer, the battery discharge energy (in watt-hours) is calculated by multiplying the voltage (in volts), current (in amperes), and sample period (in hours) for each sample, and then summing over all sample periods until the end-of-discharge voltage is reached.

3.3.9. Determining the Maintenance Mode Power. After the measurement period is complete, the technician shall determine the average maintenance mode power consumption by examining the power-versus-time data from the charge and maintenance test and:

(a) If the maintenance mode power is cyclic or shows periodic pulses, compute the average power over a time period that spans a whole number of cycles and includes at least the last 4 hours.

(b) Otherwise, calculate the average power value over the last 4 hours.

3.3.10. Determining the 24-Hour Energy Consumption. The accumulated energy or the average input power, integrated over the test period from the charge and maintenance mode test, shall be used to calculate 24-hour energy consumption.

TABLE 3.3.2—REQUIRED BATTERY DISCHARGE RATES AND END-OF-DISCHARGE BATTERY VOLTAGES

Battery chemistry	**Discharge rate** ***C***	**End-of-discharge voltage** ***volts per cell***
Valve-Regulated Lead Acid (VRLA)	0.2	1.75
Flooded Lead Acid	0.2	1.70
Nickel Cadmium (NiCd)	0.2	1.0
Nickel Metal Hydride (NiMH)	0.2	1.0
Lithium Ion (Li-Ion)	0.2	2.5
Lithium Polymer	0.2	2.5
Rechargeable Alkaline	0.2	0.9
Nanophosphate Lithium Ion	0.2	2.0
Silver Zinc	0.2	1.2

3.3.11. Standby Mode Energy Consumption Measurement. The standby mode measurement depends on the configuration of the battery charger, as follows.

(a) Conduct a measurement of standby power consumption while the battery charger is connected to the power source. Disconnect the battery from the charger, allow the charger to operate for at least 30 minutes, and record the power (*i.e.,* watts) consumed as the time series integral of the power consumed over a 10-minute test period, divided by the period of measurement. If the battery charger has manual on-off switches, all must be turned on for the duration of the standby mode test.

(b) Standby mode may also apply to products with integral batteries. If the product uses a cradle and/or adapter for power conversion and charging, then "disconnecting the battery from the charger" will require disconnection of the end-use product, which contains the batteries. The other enclosures of the battery charging system will remain connected to the main electricity supply, and standby mode power consumption will equal that of the cradle and/or adapter alone.

(c) If the product is powered through a detachable AC power cord and contains integrated power conversion and charging circuitry, then only the cord will remain connected to mains, and standby mode power consumption will equal that of the AC power cord (*i.e.*, zero watts).

(d) Finally, if the product contains integrated power conversion and charging circuitry but is powered through a non-detachable AC power cord or plug blades, then no part of the system will remain connected to mains, and standby mode measurement is not applicable.

3.3.12. Off Mode Energy Consumption Measurement. The off mode measurement depends on the configuration of the battery charger, as follows.

(a) If the battery charger has manual on-off switches, record a measurement of off mode energy consumption while the battery charger is connected to the power source. Remove the battery from the charger, allow the charger to operate for at least 30 minutes, and record the power (*i.e.*, watts) consumed as the time series integral of the power consumed over a 10-minute test period, divided by the period of measurement, with all manual on-off switches turned off. If the battery charger does not have manual on-off switches, record that the off mode measurement is not applicable to this product.

(b) Off mode may also apply to products with integral batteries. If the product uses a cradle and/or adapter for power conversion and charging, then "disconnecting the battery from the charger" will

require disconnection of the end-use product, which contains the batteries. The other enclosures of the battery charging system will remain connected to the main electricity supply, and off mode power consumption will equal that of the cradle and/or adapter alone.

(c) If the product is powered through a detachable AC power cord and contains integrated power conversion and charging circuitry, then only the cord will remain connected to mains, and off mode power consumption will equal that of the AC power cord (*i.e.*, zero watts).

(d) Finally, if the product contains integrated power conversion and charging circuitry but is powered through a non-detachable AC power cord or plug blades, then no part of the system will remain connected to mains, and off mode measurement is not applicable.

4. Testing Requirements for Uninterruptible Power Supplies

4.1. *Standard Test Conditions*

4.1.1. *Measuring Equipment.*

(a) The power meter must provide true root mean square (r.m.s) measurements of the active input and output power, with an uncertainty at full rated load of less than or equal to 0.5% at the 95% confidence level notwithstanding that voltage and current waveforms can include harmonic components. The power meter must measure input and output values simultaneously.

(b) All measurement equipment used to conduct the tests must be calibrated within the past year of the test date by a standard traceable to International System of Units such that measurements meet the above uncertainty requirements.

4.1.2. *Test Room Requirements.* All portions of the test must be carried out in a room with an air speed immediately surrounding the UUT of ≤ 0.5 m/s. Maintain the ambient temperature in the range of 20.0

°C to 30.0 °C, including all inaccuracies and uncertainties introduced by the temperature measurement equipment, throughout the test. No intentional cooling of the UUT, such as by use of separately powered fans, air conditioners, or heat sinks, is permitted. Test the UUT on a thermally non-conductive surface.

4.1.3. *Input Voltage and Input Frequency.* The AC input voltage and frequency to the UPS during testing must be within 3 percent of the highest rated voltage and within 1 percent of the highest rated frequency of the device.

4.2. *Unit Under Test Setup Requirements.*

4.2.1. *General Setup.* Configure the UPS according to Appendix J.2 of IEC 62040-3 Ed. 2.0 (incorporated by reference, see § 430.3 of this chapter) with the following additional requirements:

(a) *UPS Operating Mode Conditions.* If the UPS can operate in two or more distinct normal modes as more than one UPS architecture, conduct the test in its lowest input dependency as well as in its highest input dependency mode where VFD represents the lowest possible input dependency, followed by VI and then VFI.

(b) *Energy Storage System.* The UPS must not be modified or adjusted to disable energy storage charging features. Minimize the transfer of energy to and from the energy storage system by ensuring the energy storage system is fully charged (at the start of testing) as follows:

(1) If the UUT has a battery charge indicator, charge the battery for 5 hours after the UUT has indicated that it is fully charged.

(2) If the UUT does not have a battery charge indicator but the user manual shipped with the UUT specifies a time to reach full charge, charge the battery for 5 hours longer than the time specified.

(3) If the UUT does not have a battery charge indicator or user manual instructions, charge the battery for 24 hours.

4.3. *Test Measurement and Calculation.*

4.3.1 *Average Power Calculations.* Perform all average power measurements and calculations in this section using one of the following methods:

(a) Record the accumulated energy (E_i) in kilowatt hours (kWh) consumed over the time period specified for each test (T_i). Calculate the average power consumption as follows:

$$P_{avg} = \frac{E_i}{T_i}$$

Where:

Pavg = average power

Ei = accumulated energy measured during time period of test

Ti = time period of test

(b) Record the average power consumption (P_{avg}) by sampling the power at a rate of at least 1 sample per second and computing the arithmetic mean of all samples over the time period specified for each test as follows:

$$P_{avg} = \frac{1}{n}\sum_{i=1}^{n} P_i$$

Where:

P_{avg} = average power

P_i = power measured during individual measurement (i)

n = total number of measurements

4.3.2. *Steady State.* Operate the UUT and the load for a sufficient length of time to reach steady state conditions. To determine if steady state conditions have been attained, perform the following steady state check, in which the difference between the two efficiency calculations must be less than 1 percent:

(a) Simultaneously measure the UUT's input and output power for at least 5 minutes, as specified in section 4.3.1 of this appendix, and record the average of each over the duration as P_{AVG_IN} and P_{AVG_OUT}, respectively.

(b) Calculate the UUT's efficiency, Eff_1, using the following equation:

$$Eff = \frac{P_{AVG\_OUT}}{P_{AVG\_IN}}$$

Where:

Eff is the UUT efficiency

P_{AVG_OUT} is the average output power in watts

P_{AVG_IN} is the average input power in watts

(c) Wait a minimum of 10 minutes.

(d) Repeat the steps listed in paragraphs (a) and (b) of section 4.3.1 of this appendix to calculate another efficiency value, Eff_2.

(e) Determine if the product is at steady state using the following equation:

$$Percentage\ difference = \frac{|Eff_1 - Eff_2|}{Average(Eff_1, Eff_2)}$$

If the percentage difference of Eff_1 and Eff_2 as described in the above equation, is less than 1 percent, the product is at steady state.

(f) If the percentage difference is greater than or equal to 1 percent, the product is not at steady state. Repeat the steps listed in paragraphs (c) to (e) of section 4.3.1 of this appendix until the product is at steady state.

4.3.3. *Power measurements and efficiency calculations.* Measure input and output power of the UUT for efficiency calculations according to Section J.3 of IEC 62040-3 Ed. 2.0 (incorporated by reference, see § 430.3 of this chapter), with the following exceptions:

(a) Test the UUT at the following reference test load conditions, in the following order: 100 percent, 75 percent, 50 percent, and 25 percent of the rated output power.

(b) Perform the test at each of the reference test loads by simultaneously measuring the UUT's total input and output energy in watt-hours (Wh) over a 15 minute test period with a total energy accumulation rate of at least 1 Hz. Calculate the UUT's average input power and output power for the period using the method in section 4.3.1 of this appendix, and the efficiency for that reference load using the following equation:

$$Eff_{n\%} = \frac{P_{avgOut\ n\%}}{P_{avgIn\ n\%}}$$

Where:

Eff_n = the efficiency at reference test load n%

$P_{avgOut\ n\%}$ = the average output power at reference load *n*%

$P_{avgIn\ n\%}$ = the average input power at reference load *n*%

4.3.4. *UUT Classification.* Determine the UPS architecture by performing the tests specified in the definitions of VI, VFD, and VFI (sections 2.27.1 through 2.27.3 of this appendix).

4.3.5. *Output Efficiency Calculation.*

(a) Use the load weightings from Table 4.3.1 of this appendix to determine the average normal mode loading efficiency as follows:

$$\mathrm{Eff_{avg}} = (t_{25\%} \times \mathrm{Eff}|_{25\%}) + (t_{50\%} \times \mathrm{Eff}|_{50\%}) + (t_{75\%} \times \mathrm{Eff}|_{75\%}) + (t_{100\%} \times \mathrm{Eff}|_{100\%})$$

Where:

$\mathrm{Eff_{avg}}$ = the average normal mode loading efficiency

$t_{n\%}$ = the portion of time spent at reference test load *n*% as specified in Table 4.3.1 of this appendix

Eff|n% = the measured efficiency at reference test load n%

Table 4.3.1: Load Weightings

		Portion of time spent at reference load			
Rated output power (W)	**UPS Architecture**	**25%**	**50%**	**75%**	**100%**
P ≤ 1500 W	VFD	0.2	0.2	0.3	0.3
	VI or VFI	0	0.3	0.4	0.3
P > 1500 W	VFD, VI, or VFI	0	0.3	0.4	0.3

(b) Round the calculated efficiency value to one tenth of a percentage point.

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